Statistics 421/621 – Applied Time Series and Forecasting
Spring 2022

Instructor: Dr. Kathy Ensor; x4687; ensor@rice.edu
Lecture: MW 2-3:15
Office Hours: Wednesday from 11 to noon (zoom or in person)

TA'S: Jason Lenderman
Yangfan Ren
Office Hours: TBA
GA's: Siyi Du
Jiaqi Lu
Ying Qu

Course Objective: To educate students on the foundation and practical implementation of time series methods and forecasting. Examples will come from a broad spectrum of problems in engineering, science, social science and business including financial applications.

Textbook: (pdf's of books are freely available)

- Material will be taken from the following textbooks and R-vignettes (you do NOT need to purchase these texts).
- Forecasting: principles and practice by Rob J. Hyndman and George Athanasopoulos is found at https://www.otexts.org/fpp. We will use this text at the beginning of the course while studying simple forecasting strategies.
    - R package associated with this text is **forecast**
- Shumway and Stoffer – two texts
    - Time Series: A Data Analysis Approach Using R by Shumway & Stoffer. 1st Edition. Copyright Year 2019. ISBN 9780367221096. https://www.stat.pitt.edu/stoffer/tsda/ Published May 21, 2019 by Chapman and Hall. https://www.routledge.com/Time-Series-A-Data-Analysis-Approach-Using-R/Shumway-Stoffer/p/book/9780367221096
    - Time Series Analysis and Its Applications with R Examples by Shumway & Stoffer, 4th Edition. Pdf available for download http://www.stat.pitt.edu/stoffer/tsa4/.
    - R package for these texts **astsa**
- State-space modeling through R-package MARSS. MARSS Vignette is an excellent description of this material and will supplement the treatment in Shumway/Stoffer and Hyndman texts. DLM is another excellent package for state-space modeling.
- *In the past I have used: The Analysis of Financial Times Series* by Ruey Tsay, 3rd Edition (Data sets; errata). This is an excellent text that provides another but related perspective.

Computing Required: This course will require a substantial amount of computing and data analysis, relying on the statistical software package R (https://www.r-project.org/) through RStudio (http://rstudio.org/).

Assessment:

- 30% HW and quizzes. Unless otherwise noted, you may work together on homework but must turn in individual write-ups.
    - 8 to 10 Weekly HW assignments; reviewed for completion only. Due Thursday at noon. HW solutions will be distributed Thursday by 1pm.
    - 8 to 10 Weekly Online quizzes covering the associated HW assignment. The quiz will be available Friday morning and due by noon on Saturday. **Quizzes must be taken independently, and subject to the honor code**.
    - Weekly grade distribution is generally: HW completion/submission worth 10% and quiz is worth 90%.
- 10% Larger project style assignments (2 – partially in class March 9th and April 20th)
- 60% 2 Exams – in class graded with the assistance of Gradescope. **Subject to honor code.**
    - (30%) Exam 1 – limited time exam + unlimited computing, date TBA
    - (30%) Exam 2 – limited time + unlimited computing, date TBA
    - A single hand written page of notes will be allowed for each exam
- There will be additional exam and homework questions for STAT 621 students based on the assumption of graduate level background knowledge in statistics.

Disabilities: I encourage any student with a disability that requires accommodation to let me know as well as Rice Disability Support Services.

Topics – general outline and subject to change

- Time series basics
    - TS data, graphs and computing
    - TS decomposition and smoothing
    - TS characteristics and features
- Forecasting in theory and practice
- Basic TS models.
    - TS regression models
    - Exponential smoothing
    - WN, ARIMA, ARMAX.
    - Tests of model assumptions
    - Model comparisons and selection
- Advanced TS models
    - Seasonal models
    - VAR
    - ARCH, GARCH
- Exam 1 March 7th
- State-Space Models.

    - Local level model
    - Kalman filter, smoother and forecast
    - Hierarchical and grouped models
    - ARMAX as State Space model
    - Regime switching
    - Stochastic volatility
    - Time varying coefficient models
- Spectral Methods.
    - Periodogram – sinusoidal regression
    - Spectral density
    - Duality with time domain
    - As general functional time series
    - Advanced seasonal models
- Exam 2 April 18th